Space Weather Technical Forecast

Issued on Saturday, 15 April 2023 at 01:10 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts) throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity rose to Moderate in the UTC day of Friday 14 April, with X-ray activity recorded at GOES16 and 18 showing a rising background of more frequent C-class flares, capped by an M1.1 at 14/1618UTC and an M1.5 at 14/2327UTC, with both emanating from AR3282. This group was one of up to nine on the present disc, with the development of a small unnumbered Axx group in the southeast adding to the previous eight numbered groups.

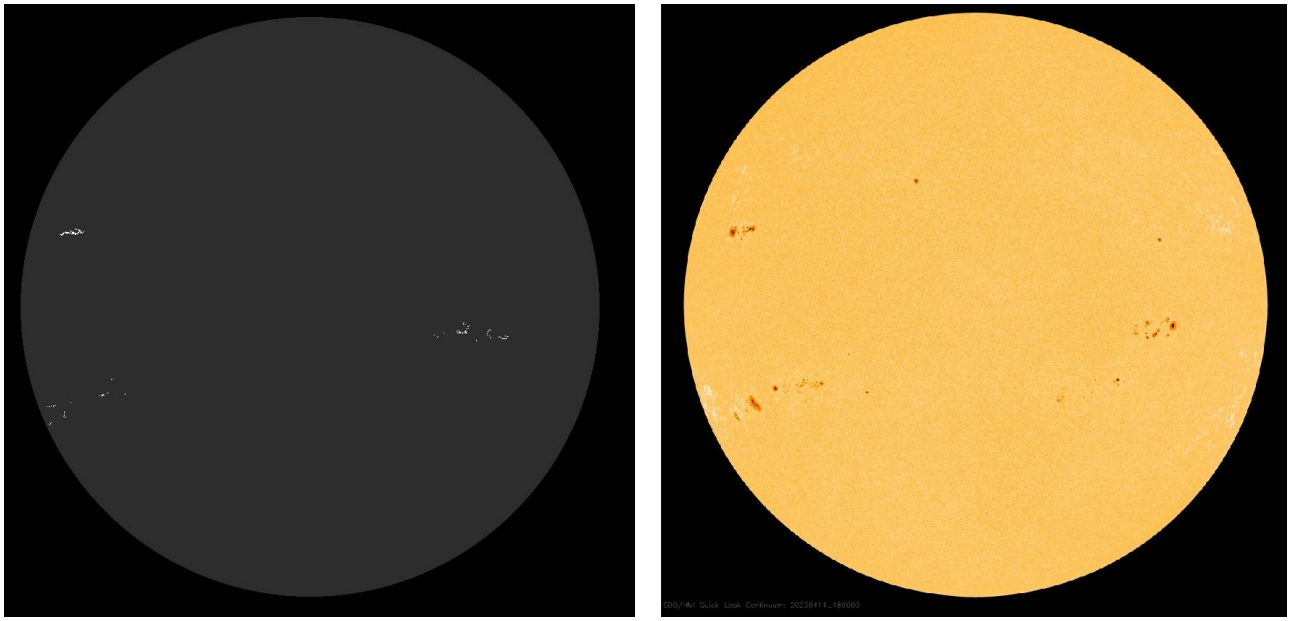

Figure 0: Left: X-ray flare locations of C-class and above in the past 24 hours (to 14/2300UTC), courtesy of SIDC ROB. Left: HMIIF imagery as at 14/1800UTC.

The main changes in the current cohort of active regions in the 24-hour period were marked penumbral growth and consolidation in AR3280, 81 and 82, whereas AR3272 - by contrast - showed fading throughout. The remaining groups were stable or unipolar and small. There are tenuous candidates for Mt Wilson delta spots in AR3280 and AR3282.

Coronagraph imagery for the period showed a large Coronal Mass Ejection (CME) heading east of the Sun-Earth line during the UTC evening, with frequent smaller releases from beyond the limb. The larger CME is thought to be related to the earlier M-class flare. This feature has been analysed, and while modelling results are not yet available, it is thought unlikely to be Earth-directed, with no new CMEs therefore thought to be en route.

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Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was at Background levels throughout in a slow regime. The solar wind speed fell from the high 300s of km/s to nearer 350km/s by the period's end. The solar wind density was within its usual range in single figures ppcc, while the IMF was at Background levels in its slightly rising tendency to a peak of 8nT. The north-south component was variable between +7 and -6nT. The phi angle was mainly positive (away from the Sun).

The net effect of the above solar wind measures was for provisionally Quiet geomagnetic activity throughout, with a peak Kp of '2-' in the 12-15 and 15-18UTC intervals.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at Background levels.

The high energy electron flux (greater than 2MeV) as measured at GOES16 was at Normal Background levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a steady trend, with 1.57e6 integrated pfu observed at 15/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low to Moderate, with a Chance of isolated M-class flares. The frequency of small CMEs from beyond the east limb is perhaps an indicator of larger active regions to come, although the risk is held constant until they present for analysis.

Solar Wind / Geomagnetic Activity: There is a low possibility of a glancing CME arrival on day two (Sunday 16 April) - this is the only CME in the forecast. Earth may also be affected by one or both of two coronal hole high speed streams from the start of the four-day period, although with both driving features being at high solar latitudes, Earth may remain unaffected and in a slow wind regime throughout.

Resulting geomagnetic activity is expected to generally be Quiet to Unsettled - perhaps remaining as such throughout. There is a Chance of Active intervals, most likely in association with any low confidence transitory CME pass.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at Background levels, although there is a Slight Chance of a greater than S1 event as some of the more complex active regions transit towards the western solar hemisphere.
High energy (greater than 2 MeV) electron flux is currently at Normal Background levels, and is now considered most likely to remain so - at least until any further fast wind enhancement(s) which are low confidence. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu), but perhaps with an eventual slight rising trend.

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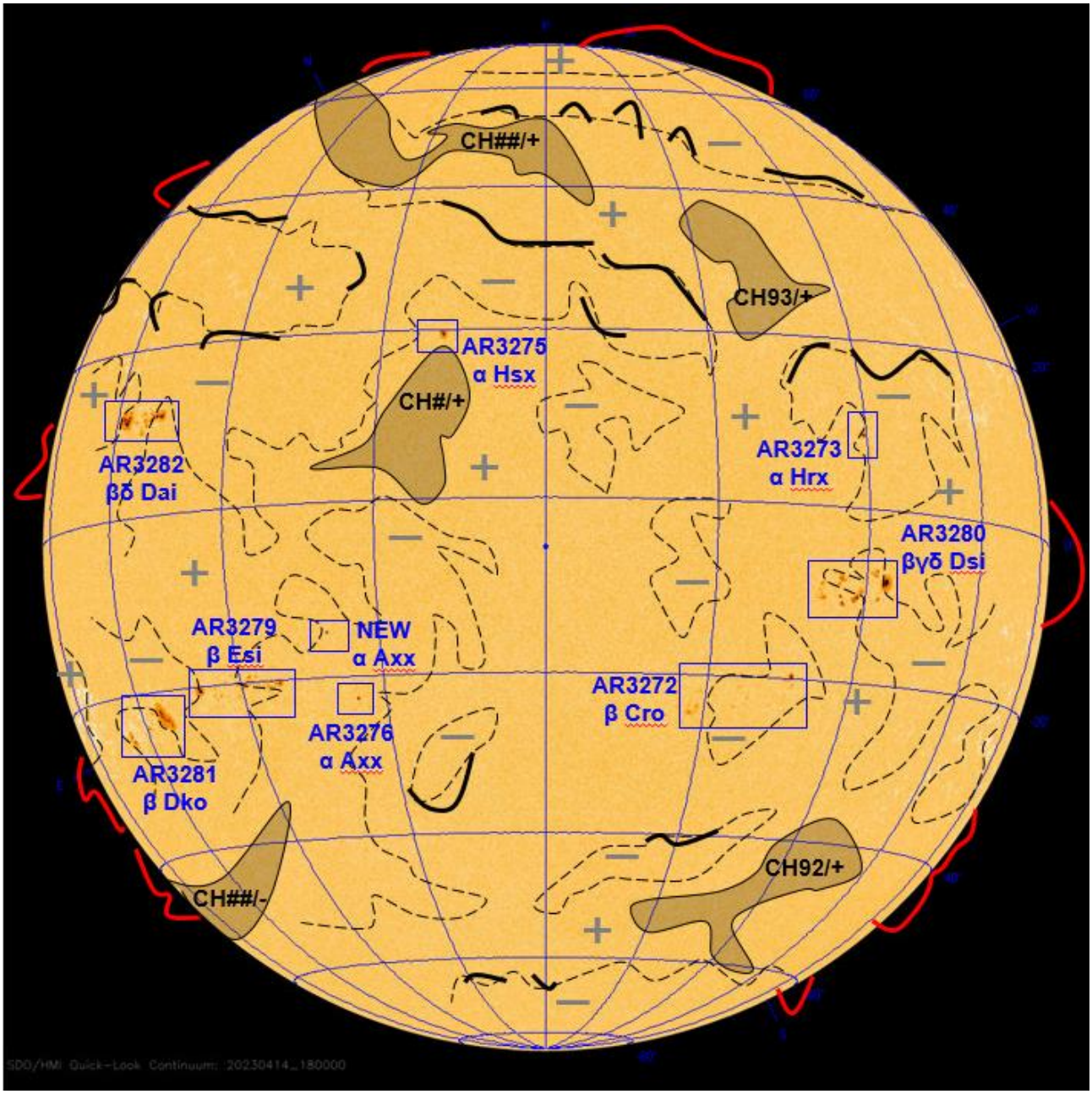
Figure 1. Solar Analysis Valid 14/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

One CME features in the current forecast in the form of a low confidence glancing blow from a filament eruption which occurred from the southwest quadrant on 12 April. The MOSWOC Enlil deterministic run has this as a miss, however a minority of Enlil ensemble members have a glancing blow on 16 April which may give a Slight Chance of G1 - the peak risk for the period as a whole.

Coronal holes potentially due in the period bear little resemblance to their last pass, and currently inhabit high solar latitudes. This may mean that Earth bypasses their influence and remains in a slow solar wind regime throughout - as at present. MOSWOC Enlil has no enhancement visible, and STEREO A has only shown minor deviations to Background solar wind speeds in the past 24 hours.

There remains a chance of further positive coronal hole influence from CH92/+ in the south, and/or CH93/+ in the north of the disc, with these potentially bringing Slightly Elevated solar winds from the start of the UTC weekend for a time, probably easing into the new working week - should they occur. Any resulting geomagnetic enhancement is expected to remain subdued, perhaps offering a Chance of Active at peak.

The forecast for geomagnetic activity is therefore for generally Quiet to Unsettled conditions throughout, but with a Chance of Active intervals, should the aforementioned glancing CME impact materialise.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0959	Partial	Filament	SW	550km/s	16/0300UTC	Low confidence

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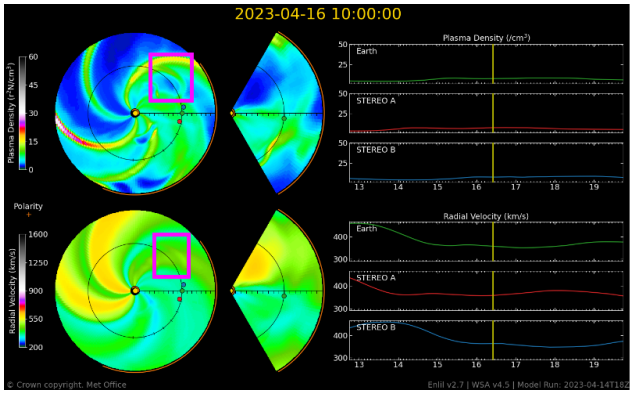
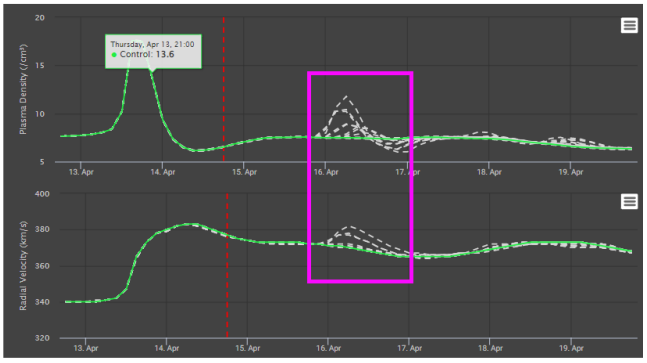
Figure 2: 14/1800UTC MOSWOC Enlil run with ensemble, showing minority of members with a glancing blow as a result of the 12 April filament eruption from the southwest quadrant. Note that the deterministic run is unmoved, and this is the preferred forecast. Note also that Enlil makes little of CH92 and CH93, although minor effects arising from these are still considered a possibility.





Radio Blackouts - X-Ray Flares:

Solar activity rose to Moderate over the past 24 hours, with AR3282 giving a nod towards its latent promise in delivering a low-level M1.1 flare at 1618UTC. The sunspot responsible was one of two to contain potential tenuous Mt Wilson delta spots in the period, the other being AR3280 in the southwest. Both of these groups also showed penumbral growth in the 24 hours, as did 3281, whereas AR3272 - the most active spot of recent days - took an opposing trend in fading from a Zurich F-group to a tenuous C.

AR3280 will lie on the western solar horizon by the end of the coming four-day period, but should still contribute to flare risk from here, and none of the current front-sided regions are expected to leave the Earth-facing disc in the period.

Meanwhile, the Carrington locations of up to three previously active regions are due over the eastern solar horizon in the four days. Certainly, the northeastern limb is seeing an increase in activity in the last 24 hours, with frequent small CMEs emitted on coronagraphs from this location perhaps hinting at the survival or reinvigoration of Ex-3260, with confirmation likely over the coming UTC weekend.

All considered, while the possible outlook is for an increase in activity, any rise in flare probabilities will be factored into the forecast once they present for analysis on the eastern solar horizon.

X Ray Flares	**Level**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability			**(%)**	**(%)**	**(%)**	**(%)**
Active	**R1-R2 M Class**	Yes	50	50	50	50
Very Active	**R3 to R5 X Class**	No	5	5	5	5

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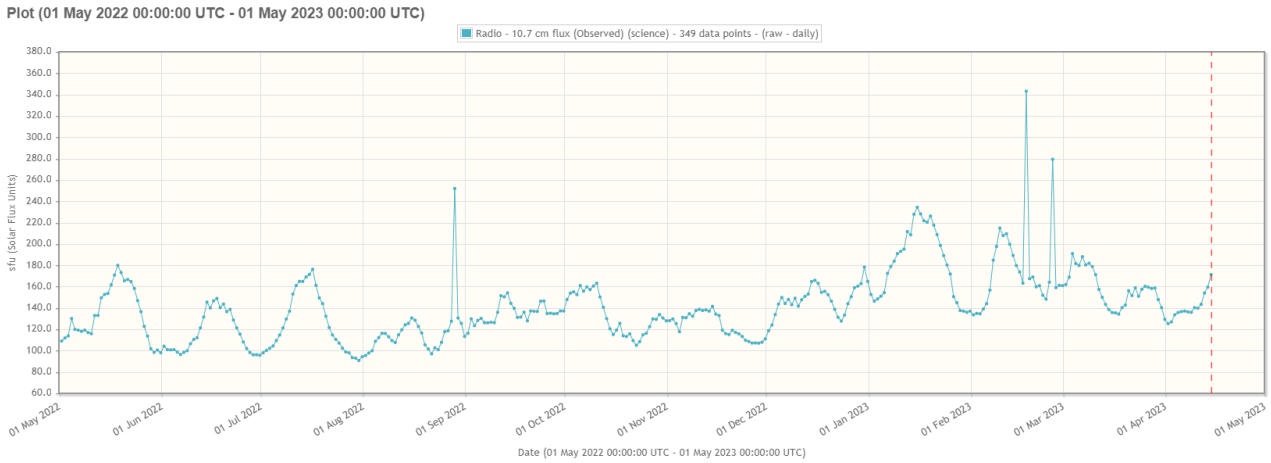
Figure 3: Observed Penticton 10.7cm radio flux from the past year – the Sun appears to be entering a new pulse of activity after last week's lull. Data display courtesy of SIDC ROB.


Plot (01 May 2022 00:00:00 UTC - 01 May 2023 00:00:00 UTC)
Radio - 10.7 cm flux (Observed) (science) - 349 data points - (raw - daily)
sfu (Solar Flux Units)
Date (01 May 2022 00:00:00 UTC - 01 May 2023 00:00:00 UTC)

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at Background levels through the period.

There is a very gradually increasing Slight Chance of a greater than S1 event as some of the larger active regions transit towards the western solar hemisphere, although this is relatively lower than recent guidance given the fading of one of the larger residents of this hemisphere - AR3272.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux is currently at Normal Background levels, and is now most likely to remain at this level in the absence of any uptick in flux following last week's CH91/+ fast wind. Any increase in the forecast period will now rely on the low confidence events of one or both of the CH92 and CH93/+ fast winds becoming geoeffective, else marginal CME effects from Sunday 16 April.

The associated 24-hour integrated fluence is currently expected to remain below the Active (1e8 integrated pfu) threshold throughout, but perhaps with a slight rising trend.

MOSWOC REFM is suggesting only minor rises, and is presently considered to be giving good guidance. The main caveat to this forecast is the low confidence fast wind(s), and also a CME that could feature - both facets that REFM does not take account of (none being persistent

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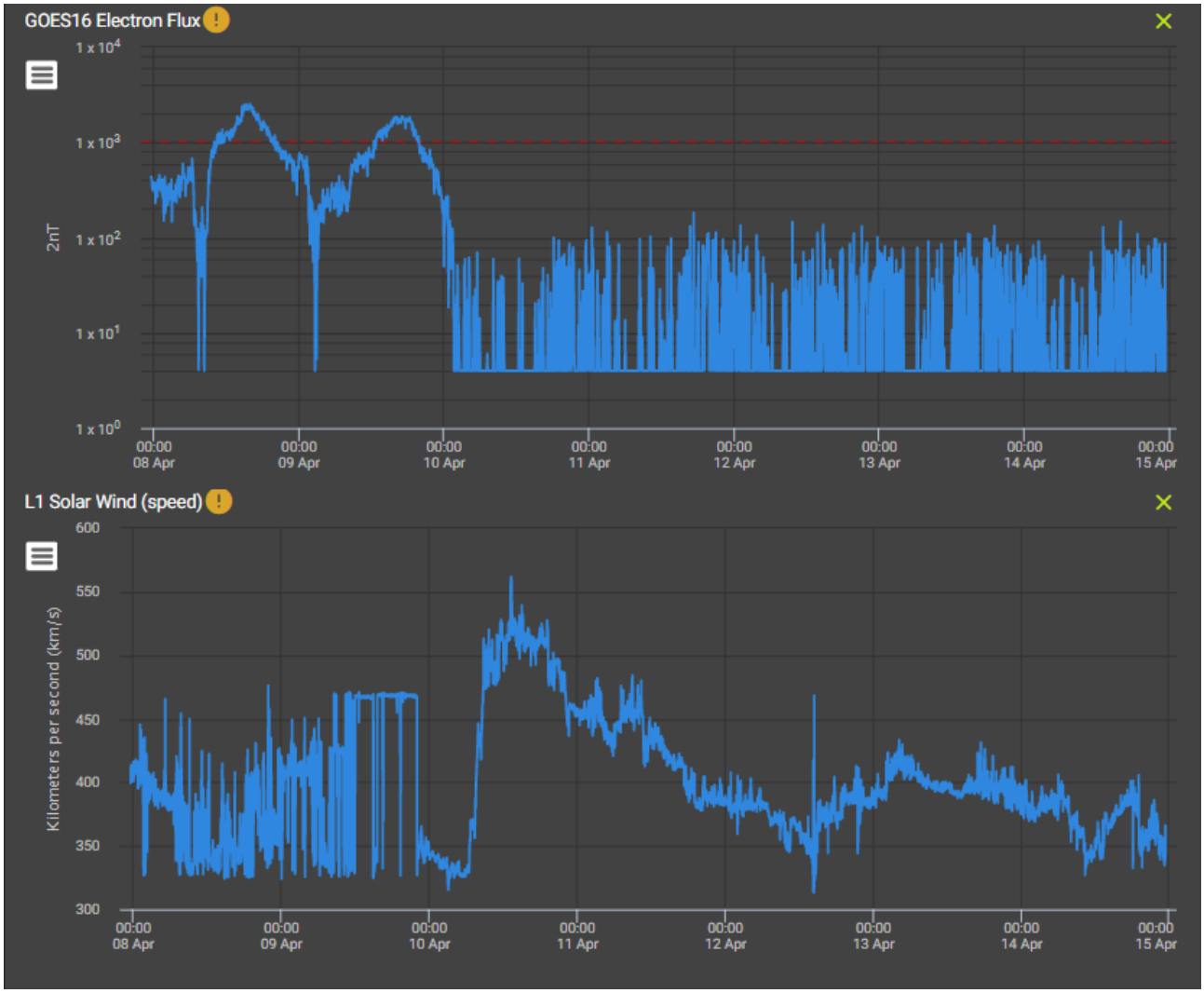
features). Forecast 'error bars' therefore increase slightly into the new working week given the uncertainties involved.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Past week in GOES16 high energy electron flux (top), showing a very damped diurnal oscillation in response to geomagnetic activity from CH91's fast wind (L1 speed shown below). Geomagnetic activity has been low enough for long enough for the present flux level to be reasonably safely assumed to be the new equilibrium state.



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